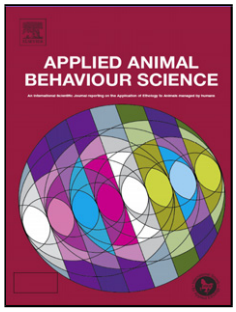

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Author: Jenna L. Kiddie Lisa M. Collins

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Identifying environmental and management factors that may be associated with the quality of life of kennelled dogs (*Canis familiaris)*

Jenna L Kiddie[a1], Lisa M Collins[*b]

[a]Veterinary Clinical Studies, Royal Veterinary College, Hawkshead Lane, North Mymms, Hatfield, Herts, AL9 7TA, UK; jenna.kiddie@anglia.ac.uk,

[b]School of Life Sciences, University of Lincoln, Brayford Pool, Lincoln, LN6 7TS; lcollins@lincoln.ac.uk.

*Corresponding author: Lisa Collins, School of Life Sciences, University of Lincoln, Brayford Pool, Lincoln, LN67TS; lcollins@lincoln.ac.uk.

[1] Present address: Department of Life Sciences, Faculty of Science and Technology, Anglia Ruskin University, East Road, Cambridge, CB1 1PT

Abstract

This paper describes the use of a validated quality of life assessment tool (described elsewhere) to identify environmental and management factors that may affect quality of life in dogs kennelled in rehoming centres. Dogs were allocated to one of four treatment groups, all of which had a positive (0.0 - 1.0) average quality of life score: long stay dogs with an enriched routine had a mean score of 0.477; long stay dogs with a standard routine had a mean score of 0.453; newly admitted dogs with an enriched routine had a mean score of 0.399; and newly admitted dogs with a standard routine had a mean score of 0.362. Only 2% of the dogs had a negative score (-1.0 - 0.0). Thirteen rehoming centre managers completed a questionnaire relating to the kennel environment and management practices of their rehoming centres. The environmental and management factors' associations with quality of life scores, collected from 202 dogs from the 13 rehoming centres using this scoring system, were analysed as fixed factors in a linear mixed-effect model, with rehoming centre fitted as a random factor, and a multiple linear regression model. There was a statistically significant association between quality of life scores and rehoming centre ($H(12) = 54.153$, $p < 0.001$), however, the fitted linear mixed-effect model did not improve upon the null model and therefore cannot be used to explain the 29% variance in quality of life scores attributed to rehoming centre. The multiple linear regression model explained 42% of the variation in quality of life scores ($F(10,131)=9.318$, $p<0.001$): the provision of bunk beds increased quality of life scores by 0.3 ($t=3.476$, $p<0.001$); provision of 30 minutes or more of staff or volunteer interaction increased scores by 0.26 ($t=-2.551$, $p=0.012$); grooming dogs decreased scores by 0.404 ($t=3.326$, $p=0.001$); exercising dogs more than once a day decreased scores by 0.173 ($t=-3.644$, $p=<0.001$), whereas exercising dogs for 30 minutes or more increased quality of life scores by 0.213 ($t=-2.374$, $p=0.019$) and the provision of less common types of exercise increased scores by 0.504 ($t=5.120$, $p<0.001$); training dogs for 30 minutes or more every day increased scores by 0.688 ($t=3.040$, $p=0.003$) and training dogs less than daily decreased scores by 0.393 ($t=-4.245$, $p<0.001$); feeding a diet of dry and wet food compared to dry food alone decreased scores by 0.08 ($t=-2.331$, $p=0.021$); and a quiet environment increased scores by 0.275 (t=-

3.459, $p<0.001$). These results suggest that environmental design and kennel management have an impact on the quality of life of kennelled dogs and should be considered carefully in decision-making processes. However, further study may be required as grooming and exercising dogs more than once per day decreased quality of life scores, which are not obviously intuitive results.

Keywords: domestic dog; quality of life; welfare; kennel; shelter

1. Introduction

Despite their popularity, many dogs are relinquished to rehoming charities every year; it has been estimated that 129,743 dogs entered such welfare organisations in the U.K. in 2009 (Clark et al., 2012). However, the kennel environment, for practical and financial reasons, is usually restricted in size and complexity and may offer only limited environmental and social stimulation (Taylor and Mills, 2007a). Previous studies suggest that dogs experience fear and anxiety immediately upon admission to the kennel environment and that the related stress response can remain activated for several days (Hennessy et al., 1997) or even several weeks (Stephen and Ledger, 2006), with a large degree of individual variation (Rooney et al., 2007). Several social and environmental factors have been shown to contribute to the short-term behavioural and physiological indicators of stress that have been observed (Hennessy et al., 1997; Hewison et al., 2014; Sales et al., 1997; Taylor and Mills, 2007a; Wells and Hepper, 1992, 1998). These acute stressors can become chronically stressful if the dog fails to adapt to them over the longer term (Beerda et al., 1999; Hubrecht et al., 1992; Morgan and Tromborg, 2007; Van Rooijen, 1991).

The quality of life (QoL) of kennelled dogs is therefore of concern for a number of reasons. QoL is defined as:

> *"the subjective and dynamic evaluation by the individual of its circumstances (internal and external) and the extent to which these meet its expectations (that may be innate or learned and that may or may not include anticipation of future events), which results in, or includes, an affective*

64 *(emotional) response to those circumstances (the evaluation may be a conscious or unconscious*
65 *process, with a complexity appropriate to the cognitive capacity of the individual)"* (Wiseman-Orr *et*
66 *al.* 2006).

67 One method of measuring QoL in kennelled dogs employs questionnaires developed for use by
68 caregivers acting as proxies for the animals, which are unable to speak for themselves (Hewson et al.,
69 2007; Kiddie and Collins, 2014; Taylor and Mills 2007a; Wojciechowska *et al.* 2005). Given the
70 current lack of general agreement on the basic needs of companion animals and the difficulty in
71 assessing individual preferences in rescue or rehoming centres, it is difficult to interpret results of any
72 causal indicators in companion animal QoL assessments (Taylor and Mills 2007b). Therefore, QoL
73 assessments should rely largely, if not wholly, on animal-based measures (Temple et al., 2011).

74

75 The purpose of the study reported here was to use a newly developed and validated QoL assessment
76 tool (Kiddie and Collins, 2014), to identify potentially influential rehoming centre environmental and
77 management factors as recorded by rehoming centre managers. The score is a binary 1/0 scoring
78 system including only animal-based measures: behavioural items that indicate positive and negative
79 quality of life as well as three physical health items. Use of this tool allows calculation of a QoL
80 score, which is the *proportion of listed positive indicators present – proportion of listed negative*
81 *indicators present.* The QoL score can therefore take any value between -1.0- +1.0. A score of -1.0
82 would occur in a case where 0% of the listed positive indicators have been observed, and 100% of the
83 listed negative indicators are present (a dog with extremely negative QoL). On the contrary, a score
84 of +1.0 would occur in a case where 100% of the listed positive indicators are present, and 0% of the
85 listed negative indicators are present (a dog with extremely positive QoL). A score of 0.0 would
86 indicate that the same proportion of listed positive and listed negative indicators have been observed
87 (a dog with neutral QoL).

88

Dogs housed in quiet, furnished kennels with access to enrichment and exercise opportunities, as well as frequent social contact with carers and other dogs, were hypothesised to have higher (better) QoL scores than dogs housed in noisy kennels with little opportunity for mental and physical stimulation or social contact.

2. Materials and Methods

2.1. Animals and treatment groups

Thirteen Dogs Trust rehoming centres recruited up to 16 dogs each from their existing population of kennelled dogs, (i) eight newly admitted dogs, and (ii) eight dogs that had been in the centre for at least 30 days (as described in Kiddie and Collins, 2014). Six centres recruited 16 dogs for each treatment group. The remaining seven centres recruited differing numbers of dogs per group, due to time constraints, giving a total actual sample size of n=202, rather than the planned n= 224. Where there were more than eight suitable dogs to choose from to allocate to each group, the centres were asked to randomly select the correct number of dogs.

The recruited dogs were randomly allocated to a further two groups: (i) four dogs from the newly admitted group and four dogs from the long stay group were allocated to a standard treatment group, where they received the standard husbandry routine for that centre; (ii) four dogs from the newly admitted group and four dogs from the long stay group were allocated to an enriched treatment group. Thus the sample of 16 dogs per centre was divided into four treatment groups as follows: group NS - dogs that were newly admitted to the centre and received standard husbandry (n = 53); group NE: dogs that were newly admitted to the centre and received an additional human-interaction enrichment programme (n = 48); group LS: dogs that were in the centre for at least 30 days and received standard husbandry (n = 52); group LE: dogs that were in the centre for at least 30 days and received an additional human-interaction enrichment programme (n = 49) (Table 1).

114

115 *2.2. Enrichment treatment*

116 The enrichment programme was carried out away from the kennel for 12 minutes on six consecutive
117 days, starting from the day of recruitment. The 12 minutes of enrichment consisted of four stages: 3
118 minutes of the handler sitting on the floor and encouraging the dog to make body contact, for
119 example, leaning against, sitting, or lying down next to the handler. The handler used slow hand
120 motions to massage the shoulders, neck, back and hindquarters of the dog and spoke to it in a soothing
121 voice. Two minutes of the handler using a soft brush to groom the dog. Five minutes of the handler
122 using clicker training to teach basic commands, such as sit or lie down. Two minutes of relaxed
123 massage as above. These specific enrichment activities were implemented as they have been found to
124 be enriching to dogs in previous studies (Hennessy et al., 1998; Hubrecht 1993; Valsecchi et al.,
125 2007).

126

127 *2.3. Assessment*

128 Two-hundred-and-two dogs from 13 Dogs Trust rehoming centres in the U.K. were each assessed by
129 two different members of staff from within each centre to allow inter-observer reliability to be
130 calculated (see Kiddie and Collins, 2014). Each dog therefore had two QoL scores, which were
131 averaged to give each dog a final QoL score and all of the dogs' scores from each centre were
132 averaged to give a mean centre QoL score.

133

134 *2. 4. Rehoming centre environmental and management factors*

135 Centre managers from the 13 rehoming centres were asked to fill in a questionnaire designed to
136 identify common differences between centre facilities and husbandry routines that might affect QoL
137 (Appendix 1). Questions related to the general noisiness of the centre's location; kennel design; what
138 the dogs were fed and how often they were fed; their exercise and training routines; how much human
139 interaction the dogs received and the nature of this interaction; and what enrichment the dogs

140 received. As some dogs require individual treatment the managers were asked to answer in general,
141 i.e. what they provided for the majority of dogs.
142
143 Additionally, sound levels within kennels were recorded using a Precision Gold Mini Sound Level
144 Meter, Model N05CC (Maplin, England) in the outside half of the kennels. Three readings each were
145 taken from an end kennel and a middle kennel in the line block design kennels, and from one kennel
146 in the parasol design. Recordings were taken in an empty kennel so as not to record the sound of a
147 resident dog, but rather what a dog would hear in its environment. Sound levels were measured in
148 decibels with A-weighting (dbA), with a fast time weighting, which measures quickly varying noise.
149 The three readings from each location were averaged to give a mean reading.
150

151 *2. 5. Statistical analysis*

152 Variance in QoL scores was examined using a linear mixed-effect model (lmer), fitted using the
153 restricted maximum likelihood (REML) procedure. QoL score was fitted as the dependent variable,
154 centre was fitted as a random factor, while the fixed factors fitted were those binomial centre
155 environmental and management factors that had a p-value less than 0.2 in univariate linear regression
156 analysis. The lmer model was then compared to a null model, without the fixed factors, and
157 intermediate models to assess goodness of fit using the log likelihood ratio test and comparing the
158 Akaike information criterion (AIC) values from each model, using the equation $\exp((AIC_{min}-AIC_i)/2)$.
159 As AIC only measures the relative quality of statistical models, a Kruskal-Wallis test was used to test
160 the null hypothesis that centre is not associated with QoL scores. A linear multiple regression model
161 was also fitted to calculate the predictive estimations of the centre environmental and management
162 factors without considering the effect of centre. The best fit model was chosen based on percentage
163 variation explained by R^2 and by an ANOVA, although ANOVAs were not possible for all
164 comparisons due to missing data and therefore differently sized datasets. Kennel design was split into
165 two categories: line block only; and line block/parasol mix, as just one of the centres had only parasol

kennels and therefore dogs would likely experience time in both types of kennel design in the other centres with a mix of design.

Differences between sound levels recorded in the three different locations were tested with an ANOVA with centre as a random effect. Additionally, overall means of the middle and end kennel readings were compared using a paired t-test, but as there was no significant difference they were averaged to give a line block reading. Line block and parasol readings were then compared using an independent t-test. All analyses were performed in R statistical programming language v3.0.1. (R Core Team, 2013).

2. 6. Ethical note

Ethical approval for this study was granted by the Ethics and Welfare Committee of the Royal Veterinary College; none of the procedures required licensing by the UK Home Office.

3. Results

3.1. QoL scores

The majority of dogs had positive QoL scores: only four (2%) dogs had a QoL score less than 0. Three of these dogs were in the NS group and the remaining dog was in the LS group. NS dogs had a mean QoL score of 0.362; NE dogs had a mean QoL score of 0.399; LS dogs had a mean QoL score of 0.453; and LE dogs had a mean QoL score of 0.477.

187 *3. 2. Rehoming centre environmental and management factors*

188 There was considerable variability between the 13 rehoming centres in their husbandry practices and
189 environments: feeding; exercise; human interaction; environmental enrichment; training (Table 2);
190 external noise levels; group housing; bedding; and kennel design (Table 3)

191

192 *3. 3. Multivariate analysis of rehoming centre environmental and management factors'*
193 *associations with QoL scores*

194 Centre environmental and management factors that had a p-value less than 0.2 in univariate linear
195 regression analyses were fitted to the linear mixed-effect (lmer) model (Table 4).

196

197 QoL scores were significantly associated with Centre ($H(12) = 54.1526$, $p < 0.001$). However,
198 calculation of the intraclass correlation coefficients from the fitted lmer model (Table 5) indicate that
199 only 29% (ICC1=0.287) of the variation in QoL scores is explained by centre, but that centre can
200 reliably be differentiated in terms of QoL scores (ICC2=0.848). The fitted lmer model was not
201 significantly different to the null model ($X^2(10)=3.2709$, $p=0.974$), indicating that the addition of the
202 fixed factors to the model did not produce a significantly better fit. Application of the AIC did not
203 find a better intermediate model.

204

205 A multiple linear regression model with the same fixed factors fitted explained 42% of the variation in
206 QoL scores ($F(10,131)=9.318$, $p<0.001$) (Table 6). Model 2 was chosen as the best fit model as the
207 addition of the experimental variable, treatment group, did not statistically improve the fit of the
208 model ($F(-1,131)=1.9473$, $p=0.165$). However, fitting all of the centre environmental and
209 management factors that were significant at p=0.02 in the univariate analysis did lead to an increase in
210 percentage variation in QoL scores explained in relation to models that were only fitted with fixed

211 factors that were significant at p=0.01 in model 2 (model 3) and at p=0.001 in model 2 (model 4). The
212 significant fixed factors in model 2 related to: the provision of bunk beds (Fig 1a); grooming dogs
213 (Fig 1b); exercising dogs (Fig 2a,b,c); staff or volunteer interaction (Fig 2d); training (Fig 3); exterior
214 noise levels (Fig 4a); and feeding (Fig 4b).

215

216 *3.4. Sound levels*

217 No statistically significant differences were found between the sound levels measured from the middle
218 of line blocks (mean=68.14dBA±2.92), the end of line blocks (mean=65.24dBA±2.47), and parasol
219 kennels (mean=61.63dBA±2.62) (ANOVA: F(2)=0.579, p=0.567). Nor were any differences found
220 between the combined line block sound levels (mean=66.69dBA±1.9) and parasol kennel sound
221 levels (t(20)=1.006, p=0.327, effect size d=0.91).

222

223 4. Discussion

224 This study aimed to identify environmental and management factors that may affect quality of life
225 (QoL) of kennelled dogs using a scoring system previously developed to assess the QoL of kennelled
226 dogs at a moment in time. The reliability and validity of this scoring system was previously tested
227 through its use in Dogs Trust rehoming kennels by the rehoming centre staff (Kiddie and Collins,
228 2014).

229

230 The average QoL scores of the four treatment groups were all positive and only 2% dogs had a
231 negative QoL score. This means that, on the whole, the dogs exhibited a greater proportion of positive
232 indicators than negative indicators of QoL, suggesting that dogs kennelled in Dogs Trust rehoming
233 centres have positive QoL. The four dogs that had negative QoL were from dogs in the treatment
234 groups that received standard routines and therefore no additional enrichment; three of them

235 unsurprisingly being newly admitted dogs. Giving dogs an additional programme of enrichment
236 improved QoL and dogs that had been in their respective centres for 30 days or more also had better
237 QoL (Kiddie and Collins, 2014). These results are in agreement with previous studies, which suggest
238 that dogs adapt to the kennel environment over time (e.g. Hennessy et al. 1997; Rooney et al. 2007;
239 Stephen & Ledger 2006) and that environmental enrichment helps animals to cope with their
240 environments (e.g. Graham et al. 2005; Hetts et al. 1992; Hubrecht 1993; Schipper et al. 2008;
241 Valsecchi et al. 2007; Wells et al. 2002).
242
243 Twenty nine percent of the variation in QoL scores was explained by the random factor rehoming
244 centre, as indicated by the linear mixed-effect (lmer) model. Therefore, 71% remains unexplained by
245 rehoming centre, i.e. the dogs' location at the time of QoL assessment. The addition of fixed factors to
246 the lmer model did not produce a significantly better fit than the null or intermediate models.
247 Therefore, the fixed factors found to be significant coefficients in the fitted lmer model must
248 contribute to QoL scores independent of rehoming centre. Their effect on QoL scores was therefore
249 investigated using a linear multiple regression model, without fitting rehoming centre. Only ten of the
250 18 fixed factors entered into the model remained in the final model, all of which had a statistically
251 significant relationship with QoL scores, when the effects of the other factors were held constant, and
252 explained 42% of the variation in QoL scores.
253
254 Environmental enrichment has been shown by several studies to improve the welfare of many species
255 in captivity (e.g. Graham et al., 2005; Hogan et al., 2010; Hubrecht, 1993; Mallapur et al., 2007;
256 Matheson et al., 2008), including the addition of raised platforms to kennels (Hubrecht, 1993).
257 Hubrecht (1993) suggested that the addition of platforms improves the dogs' view from their pens and
258 may therefore reduce frustrated attempts to see what is going on beyond their kennel. He also
259 suggested that platforms increase the complexity of the kennel environment and the usable space.
260

Quality of life scores were predicted to improve with increasing time that kennel staff or volunteers spent with the dogs. This is concurrent with previous studies that have implemented additional human-animal interaction programmes (e.g. Coppola et al., 2006; Normando et al., 2009; Shiverdecker et al., 2013). For example, Bergamasco *et al.* (2010) found that a programme of human-animal interaction improved behavioural and physiological measures - heart rate variability and salivary cortisol - that may reflect animal welfare. In this study, training duration and frequency predicted an increase in QoL scores. This result was expected as training involves mental and physical stimulation, time out of the kennel and close interaction with people (the staff member or volunteer training them). It also reinforces calm, relaxed behaviour that will improve QoL, if this behaviour reflects a calm and relaxed emotional state. A study using positive and negative reinforcement consistently in shelter dogs found that trained dogs had higher adoption rates than control dogs due to improved behaviour (Luescher and Tyson Medlock, 2009), which is likely to be a reflection of improved QoL. Consistency is also related to the occurrence of undesirable behaviours (Casey et al., 2007) and is therefore likely to be related to the underlying emotional state leading to these behaviours. Rehoming centres that implement training programmes may be more likely to interact more consistently with the dogs in their care.

Increased exercise duration also predicted higher QoL scores. Other studies have previously found that exercise is positively correlated with welfare. For example, military working dogs exercised less often tended to rest less and stereotype, bark and visit the veterinarian more frequently. Additional exercise promoted restful daytime behaviour such as lying down, time spent in the sleeping compartment and lower urinary cortisol:creatinine (Gaines, 2008). Menor-Campos *et al.* (2011) found that a programme of exercise and human contact increased shelter dog welfare, although how much the exercise in relation to the human contact contributed to this effect is not known. This result may be contributed to the hypothesis that exercise releases endorphins (Farrell et al., 1987) which may positively affect mood (Harte et al., 1995), however, there is still uncertainty attached to this hypothesis (see Dishman and O'Connor, 2009 for a review).

Although increased daily exercise duration predicted higher QoL scores, exercise more than once per day predicted lower QoL scores. This might suggest that fewer but longer exercise sessions would be more beneficial than shorter, more frequent exercise sessions, as the accumulated arousal caused by being moved in and out of the kennel may be detrimental to dogs.

Grooming predicted lower QoL scores: a possible explanation for this may be that if dogs are groomed on entering kennels, such intense handling by unfamiliar people at this time may have a negative impact on QoL. However, one study that implemented a human-animal interaction programme on the dogs' second day in a shelter, that included grooming, found that salivary cortisol levels were lower than in control dogs. This affect may only have been short-lived however as cortisol levels were only significantly lowered on the following day and not on later days (Coppola et al. 2006). Alternatively, some other aspect of the grooming may have been negative to the dogs. For example, Hennessy *et al*. (1997) found that although 20 minutes of petting did not affect cortisol levels of dogs that had only been in a shelter for three days, the gender of the petter did have an effect: plasma cortisol levels were lower when dogs were petted by a female than when petted by a male. However, information regarding the timing of grooming in relation to the dogs' admission to kennels or the gender of the staff members carrying out the enrichment programme in this study was not collected, therefore this would need to be investigated further to better interpret this result.

The addition of wet food to dry food at meal times predicted lower QoL scores. The addition of wet food did not affect meal timings or delivery methods of food to the dogs, therefore other reasons are speculated to cause these differences. Wet food may lead to weight gain (Lund et al., 2006) and periodontal disease (Watson, 1994), both of which might cause general discomfort to a dog or discomfort directly associated with eating, or related illnesses, thereby lowering QoL. Speculation also suggests that as wet food takes longer to prepare and clean up, its addition may reduce time spent interacting with the dogs and as has already been stated, human-animal interactions have been found to improve kennelled dog welfare. Wet food is also likely to spoil quicker, reducing the quality of the

315 food consumed by the dogs. Eating dry food might take longer and therefore may be more enriching
316 than eating a reduced portion of dry food with the calorific balance made up by the addition of wet
317 food.
318
319 Kennel design was not found to be a significant predictor of QoL scores. Sample size calculations
320 carried out prior to data collection and effect size analysis post data collection suggest that there was
321 enough power in the study to detect a real effect, should this exist. Line block kennels were expected
322 to promote better QoL (Key, 2008) but the specific design of each kennel type varied between centres.
323 Additionally, because there was only one centre that had only parasol kennels, parasol kennels had to
324 be categorised with line block in those centres that had both or just parasol kennels. If more parasol
325 only centres had existed, so that parasol could be analysed as a completely separate category, a
326 significant result may have been found.
327
328 No statistically significant differences were found between sound levels taken from line block and
329 parasol kennel designs either. Post-hoc power analysis indicates that the sample size was sufficient to
330 detect a significant difference, although there was a large effect size suggesting that there was a large
331 difference between the sound levels of the two locations. Therefore, this result might warrant further
332 investigation. Key (2008) states that single line block kennels are better for dog welfare than the
333 circular designs as the kennels are quieter: the sleeping areas of the kennels do not face each other,
334 thereby reducing noise, stress and frustration. However, some of the parasol kennels in this study had
335 been modified by opaque doors partitioning the interior communal area of the kennels, thus
336 preventing the dogs from seeing each other. The staff of these centres reported that this modification
337 led to quieter kennels in relation to previous conditions. Another reason that may explain the lack of
338 difference between the noise levels of line block and parasol kennels is that the line block kennels
339 were not categorised as single design or double design. According to Key (2008), double line block
340 designs are less suitable for dog welfare than single block designs as the dogs face each other: this

leads to higher stress levels and consequently high levels of noise, especially when holding large numbers of dogs or where there is a high turnover of dogs. However, this effect will depend on how close the sleeping areas of the two lines are to each other. Therefore, any noise effect might have been diluted by the combined categorisation of single and double line blocks.

However, higher QoL scores were predicted in centres that were located in quiet areas. Quiet locations might have been less stressful for the dogs, which is concurrent with previous findings that sound pressure in dog kennels can rise to levels that are likely to be detrimental to the health and welfare of the dogs (Coppola et al., 2006; Sales et al., 1997; Scheifele et al., 2012; Tod et al., 2005). Therefore, it is important to design kennels in such a way as to minimise the noise created within the kennels and also the noise created externally, i.e. from the surrounding area.

One surprising result was that the addition of treatment group did not significantly improve the fit of the multiple linear regression model. This result might suggest that the effect of the included fixed factors, discussed above, had a greater impact on the dogs' welfare than length of stay in kennels or the additional social enrichment provided in this study.

A limitation to this study was the quality of questionnaire answers provided by the centre managers, which may in part have been due to the questionnaire design. Managers stated during the centre visit that they found it difficult to complete the questionnaire as they treat individual dogs differently depending on their specific needs, for example some dogs only need feeding twice a day, but some require three meals daily. Therefore, they struggled to answer for an “average” dog. Also, some managers omitted certain information, whether intentionally or accidentally is not known - given the time limits of the study this was not followed up. For example, one centre had a scent garden for the dogs to exercise in and another centre hung herbs such as lavender in kennels with the intent of

366 calming dogs (personal observation), but these were not recorded in the questionnaire as would
367 perhaps be expected under "Do the dogs receive any extra enrichment?". It is also possible that some
368 centres included in this study did use some form of positive punishment. On previous visits to one of
369 the centres positive punishment methods were observed on a couple of occasions, such as spraying
370 water at, or shouting at, barking dogs or kennel mates showing minor aggression to each other. Both
371 shouting and spraying water were used as examples of punishment on the questionnaire for this
372 reason. However, the centre managers were not questioned as to why they omitted this information,
373 therefore the reasons for the omissions remain unknown.

374

375 In summary, the use of the score's results allowed potential centre environmental and management
376 level factors influencing QoL to be investigated. Exercising dogs more than once per day, grooming
377 dogs and feeding wet food in addition to dry food predicted a decrease in QoL scores. The provision
378 of 30 minutes or more of interaction with staff and volunteers, exercise and training per day, as well
379 as the provision of less common types of exercise predicted an increase in QoL scores, as did the
380 provision of bunk beds in the kennels and the centre being located in a quiet environment. These
381 results can help guide decision-making by staff. Staff should consider exercising and training their
382 dogs for at least 30 minutes per day and offer a range of exercise opportunities, such as swimming and
383 Tellington TTouch groundwork. Encouraging staff to think more widely and imaginatively regarding
384 what local exercise opportunities are available to their dogs will therefore likely be of benefit to the
385 QoL of dogs in their care. Guidelines explaining the most appropriate training methods should be
386 disseminated to all staff and practical demonstrations would also likely be beneficial. Staff should
387 aim to spend a similar length of time with the dogs, they should therefore avoid just putting their dogs
388 straight into a paddock for exercising independently of people. However, grooming as an interaction
389 between dogs and the staff or volunteers should be considered carefully. Kennels should be designed
390 so as to minimise external and internal noise and the addition of kennel furniture such as bunk beds
391 should also be a design feature. Unless there is a medical reason for feeding dogs a wet diet, centre

managers should consider feeding a dry diet only. These recommendations are likely to improve QoL of kennelled dogs, which in turn may have a positive effect on their behaviour in the kennels. This may increase adoption rates if the dogs' behaviour becomes more desirable to potential adopters. However, the centre environmental and management factors measured in this study do not fully explain the variance in QoL scores. Therefore, there must be other causes of variance not measured here that are important to the QoL of kennelled dogs.

The questionnaire used in this study would be a suitable tool for use in further investigations into factors that affect the QoL of dogs kennelled in a diverse range of environments. Because this questionnaire has been designed to be easy for staff to use, kennel managers can use this tool to evaluate the effects of their own interventions on dog QoL in order to help guide their own decision-making processes.

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531

532 **Tables**

533 **Table 1.** Number of dogs in each treatment group

534

535 **Table 2.** Management factors with variation at the rehoming centre level

536

537 **Table 3.** Environmental factors with variation at the rehoming centre level

538

539 **Table 4.** Rehoming centre design and management factors assessed by univariate linear regression for
540 inclusion in a linear mixed-effect model and a multiple linear regression model.

541

542 **Table 5.** Estimates of fixed factors fitted to a linear mixed-effect model, assessing the effects of
543 environmental and management factors on the quality of life scores of dogs kennelled in rehoming
544 centres

545

546 **Table 6.** Multiple linear regression model, explaining the variability contributed to QoL scores of
547 kennelled dogs by centre environmental and management factors

548

549 **Appendix 1.** Questionnaire disseminated to centre managers for completion prior to data collection

550

551 **Figure legends**

552 **Figure 1.** Box plots of the median QoL scores calculated for the dogs at rehoming centres that a)
553 provided or did not provide bunk beds, and b) did nor did not groom their dogs.

554

555 **Figure 2.** Box plots of the median QoL scores calculated for a) the dogs at rehoming centres that
556 provided different frequencies of daily exercise, b) different durations of daily exercise, c) other types
557 of exercise, and d) and that did or did not provide 30 minutes or more of carer interaction with the
558 dogs.

559

560 **Figure 3.** Box plots of the median QoL scores calculated for a) the dogs at rehoming centres that
561 provided less than daily or daily dog training sessions and b) that did or did not provide 30 minutes or
562 more of daily training.

563

564 **Figure 4.** Box plots of the median QoL scores calculated for the dogs at rehoming centres that a) were
565 or were not located in quiet environments and b) fed their dogs dry food only or dry and wet food.

566

566 Highlights

567 • The quality of life of kennelled dogs varies between rehoming centres

568 • The majority of dogs in this study had good quality of life

569 • Modelling identified several influential centre-related factors

570 • Environmental design and kennel management should be carefully considered

571

Treatment group	Number of dogs (n)
Dogs that were newly admitted to the centre and received standard husbandry (NS)	53
Dogs that were newly admitted to the centre and received an additional human-interaction enrichment programme (NE)	48
Dogs that were in the centre for at least 30 days and received standard husbandry (LS)	52
Dogs that were in the centre for at least 30 days and received an additional human-interaction enrichment programme (LE)	49

Centre environmental and management factor	p value	d.f.	F statistic
Groom as interaction	<0.001***	156	14.13
Kongs® provided	<0.001***	180	16
Toys provided	<0.001***	180	12.48
Noisy environment	<0.001***	180	16.01
Adaptil™	<0.001***	180	12.48
Other exercise	0.002***	180	10.11
Training frequency	0.002***	168	9.946
Training duration	0.003***	168	8.876
Carer duration	0.004***	180	8.718
Sound level	0.006***	180	7.794
Treatment group	0.007**	180	7.403
Other enrichment	0.012**	180	6.465
Daily exercise length	0.016**	164	5.926
Bunk beds	0.019**	180	5.628
Diet	0.027**	164	5.012
Quiet environment	0.041**	180	4.231
Intermittently noisy	0.062*	180	3.535
Daily exercise frequency	0.09*	180	2.905
Singly housed	0.113*	180	2.532
Daily feed frequency	0.154*	180	2.051
Training provision	0.203	180	1.634
Indoor line block housing	0.22	180	1.518
Negative reinforcement	0.2651	168	1.25
Talk and stroke interaction	0.2844	156	1.154
Just blankets	0.342	180	0.9064
Other training	0.475	168	0.5136
Single indoor pens	0.537	180	0.3819
Small group housing	0.685	180	0.1646
Line block with bar fronts	0.796	180	0.06695
Line block with glass fronts	0.866	180	0.02855
Kennel design	0.88	180	0.02288
Other beds	0.97	180	0.0014

Note: factors denoted with an (*) were significant at p<0.2 and were therefore entered into the linear mixed model; factors denoted with (**) were significant at p<0.05 and with (***) were significant at p<0.01

	Estimate	S.E.	t value	p-value
(Intercept)	0.1437	0.16209	0.887	0.377
Bunk beds	0.2834	0.10053	2.820	0.005**
Carer time	-0.0985	0.04377	-2.251	0.026*
Adaptil™	0.5076	0.20828	2.437	0.016*
Exercise frequency	0.2697	0.09952	2.710	0.008**
Exercise length	-0.0288	0.05890	-0.489	0.6252
Feeding frequency	-0.0639	0.06199	-1.031	0.304
Diet type	-0.1005	0.05809	-1.730	0.086
Intermittent noise	-0.1569	0.08564	-1.832	0.069
Kongs®	-0.3662	0.11426	-3.205	0.002**
Quiet environment	-0.2607	0.08151	-3.199	0.002**

AIC	BIC	LogLik	deviance	REMLdev
-220.3	-179.8	123.1	-295.1	-246.3

Random effects:

Groups	Name	Variance	S.D.
Centre	(intercept)	0.001898	0.04357
Residual		0.009652	0.09825

Number of obs: 166, groups: Centre, 12

Note: independent variable: quality of life scores; fixed factors: centre environmental and management factors; random factor: rehoming centre. *p<0.05, **p<0.01, ***p<0.001

Model 2	Estimate	S.E.	t value	p-value
(Intercept)	-0.26437	0.1843	-1.435	0.154
Bunk beds	0.3	0.0863	3.476	<0.001
Exercise frequency	-0.17313	0.04751	-3.644	<0.001
Exercise duration	-0.2125	0.08951	-2.374	0.019
Other exercise	0.50437	0.09851	5.12	<0.001
Training duration	0.68833	0.22642	3.04	0.003
Training frequency	-0.39312	0.09261	-4.245	<0.001
Carer time	-0.25896	0.10152	-2.551	0.012
Groom	0.40437	0.12158	3.326	0.001
Diet type	-0.07958	0.03415	-2.331	0.021
Quiet environment	-0.275	0.07949	-3.459	<0.001

Note: Dependent variable: QoL score, R^2=0.4243 for model 1, R^2=0.4157 for model 2 (ΔR^2=0.0086, p=0.1653), R^2=0.3082 for model 3 and R^2=0.2214 for model 4, *p<0.05, **p<0.01, ***p<0.001

Table

Centre no.	Exterior noise levels	Kennel design	Social housing	Bedding*
1	Quiet, woodland	Line block with glass and bar fronts	Single and pairs	Some dogs provided with bunk beds
2	Quiet	Line block with glass fronts (some indoors)	Single and pairs	Some dogs provided with bunk beds
3	Quiet	Parasol and line block with bar fronts	Single, pairs and small groups	Some dogs only provided with blankets
4	Quiet but under flight path	Line block with glass and bar fronts	Single and pairs	Some dogs provided with bunk beds
5	Quiet, rural	Parasol and line block with bar fronts	Pairs	Some dogs only provided with blankets
6	Quiet	Line block with glass and bar fronts	Pairs	n/a
7	Quiet	Line block with glass fronts	Single and pairs	Some dogs provided with bunk beds or arm chairs
8	Noisy	Parasol and line block with bar fronts	Single and pairs	Some dogs provided with sofas
9	Rural, quiet	Line block with bar fronts (some single indoor pens)	Single and pairs	n/a
10	Quiet but jets, gun shots, busy road	Line block with glass fronts	Single and pairs	Some dogs only provided with blankets
11	Noisy, airport and railway	Line block with glass and bar fronts (some indoors)	Single, pairs and small groups	Some dogs provided with other types of bed
12	Quiet	Line block with glass and bar fronts	Single and pairs	n/a
13	Quiet	Parasol	Single and pairs	Some dogs provided with sofas

* in addition to beds and blankets, which all dogs had access to

Table

Centre no.	Feed times/day	Food	Exercise Frequency/ day	Exercise type*	Exercise length (mins)	Carer time (mins)	Carer interaction	Toys	Training Frequency	Training Length (mins)	Training type
1	2	Dry and tinned	2	n/a	30	60	talk, stroke, groom, train, and play	Toys, Kongs and Adaptil	Daily	10	Positive reinforcement only
2	2	Dry	3	n/a	5-20	5-20	talk, stroke, groom, train, and play	Toys, Kongs and Adaptil	Daily or less	5to15	Positive and negative reinforcement/negative punishment
3	2	Dry	1	Swimming	15	10	talk, stroke, groom, train, and play	Toys, Kongs and Adaptil	Daily	5to20	Positive reinforcement only
4	2	Dry	2	n/a	20to30	40	talk, stroke, groom, train, and play	Toys, Kongs, Adaptil and scent garden	Daily	30	Positive reinforcement only
5	2	Dry	1 or 2	n/a	20	0	None	Toys, Kongs, Adaptil and stuffed toilet roll	None	n/a	n/a
6	1, 2, or 3	?	1	n/a		180-240	Groom, train, and play	Toys, Kongs and Adaptil	Daily	30	Positive reinforcement only
7	2	Dry	1 or 2	Training sessions	45	15	Train and play	None	Daily	15-30	Positive reinforcement only
8	2	Dry and tinned	2 or 3	n/a	10-30	10-30	talk, stroke, groom, train, and play	Toys, Kongs, Adaptil, paddling pools and carpets	Twice weekly	2to10	Positive reinforcement only
9	2 or 3	Dry	1 or 2	Groundwork	20-40	0	Train	Toys, Kongs and Adaptil	Daily or less	10to20	Positive and negative reinforcement/negative punishment and TTouch groundwork
10	2 or 3	Dry	1	n/a	75-90	0-45	talk, stroke, groom, train, and play	Toys, Kongs, Adaptil and a choice of bedding/bones	Daily	5to15	Positive and negative reinforcement/negative punishment
11	2	Dry	2 or 3	n/a	20	25	talk, stroke, groom, train, and play	Toys, Kongs and Adaptil	Daily or less	20	Positive reinforcement only
12	2 or 3	Dry	1	n/a	15	15	talk, stroke, groom, train, and play	Toys, Kongs, Adaptil and chews	Daily	15	Positive reinforcement only
13	2	Dry and tinned	2, 3 or 4	n/a	30	30	talk, stroke, groom, train, and play	Toys and Adaptil	Daily	1to5	Positive and negative reinforcement/negative punishment

*in addition to lead-walking and free-running

? missing response

Table

Centre Name:					
Please answer for the majority of dogs. Circle all options that apply, where appropriate					
Is the centre in a noisy or quiet location? E.g. Beside a motorway, airport, building site.					
Kennel design:	Parasol	Line block w/ glass front	Line block w/ bar front	Mix of parasol and line	Other:
Are dogs generally housed:	Singly	In pairs	Small groups	Large groups	
Do the kennels have:	Beds and blankets	Just blankets	Other:		
Are the dogs fed (daily):	Once	Twice	Three times		
What are most dogs fed?					
How often are the dogs exercised?					
What type of exercise do the dogs receive?	Lead walking	Free running	Other:		
How long does the exercise session last?					
How often does a carer spend time with the dogs, other than during routine cleaning and feeding? (mins/day)					
What does the carer do with the dogs during this time?	Talk and stroke	Groom	Train	Play	Other:
Do the dogs receive any extra enrichment?	Toys	Stuffed Kongs	DAP collar or diffuser	Other:	
Do the dogs receive any obedience training?	Yes	No			
If yes:					
How often are they trained?	Daily	Twice weekly	Other:		
How long are training sessions? (mins)					
What method of training is used?	Positive reinforcement, e.g. Clicker training or reward with food/play	Negative reinforcement, e.g. Ignoring inappropriate behaviour/removing a toy	Punishment, e.g. Shouting at the dogs or spraying with water	Other: